

Reliability Issues In Online Applications Of Private Learning Institutions In Malaysia

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Abstract: Private Learning Institutions in Malaysia face several challenges in the online application they offer for prospective students. These challenges cause several liability issues in the industry and prevents the application from evolving with technological advancements. In order to understand industrial liability, reliability management issues were identified and further broken down to analyze the effects of the issue. Based on the study, reliability issues pertaining to the application's infrastructure, database, and interface were recognized. Subsequently, solutions were suggested to eliminate the challenges and enhance the reliability of the online applications provided by the Private Institutions. The solutions developed guaranteed user satisfaction as applicants who utilize the system vary from different backgrounds and age. Additionally, the system was able to permit the implementation of new requirements without experiencing data loss or defects within the system. Based on the suggestions, the relevance of the reliability issues was discussed regarding the system's development in order to justify that the proposed solution enhanced the system's reliability.

Index Terms: Reliability Issues, Online applications, Human Reliability

1. INTRODUCTION

The process of ensuring that the end product is able to run with minimum failures and downtime is known as reliability management. It is understood that a system's reliability contributes to the end user's productivity with regards to the utilization of the system. Reliability management can be further broken down into two main aspects; system reliability and human reliability. System reliability covers aspects pertaining to the systems functionalities and ensuring that minimum repairs are required; hence the system's runtime is prolonged. Whereas, human reliability generally involves the users as it must guarantee that the system is user friendly; therefore, it enhances the throughput in which the user is able to complete a specific task. Some reliability characteristics include maintainability, availability, and dependability. By adjusting these characteristics, a system's quality in terms of reliability would be enhanced and tailored directly to the functional and non-functional requirements. Online applications reflect a learning institution's ability to provide its services and expertise with quality. However, online applications of various Private Learning Institutions in Malaysia face several challenges with regards to reliability management. This commonly leads to several liability issues that affect the number of students enrolling to a Private

Learning Institution in a year. These issues arise due to the impracticality of the online application rather than its availability and maintainability. This may be exemplified in a scenario where the online application does not serve its purpose and involves redundant tasks for the applicant. Therefore, proper reliability management during the development of the application would assist in overcoming the liability issues encountered. This paper aims to evaluate the reliability management issues encountered by Private Learning Institutions in Malaysia in order to understand industrial liability. Additionally, the literature review shall further break down the reliability issues into three separate components: infrastructure, database, and human reliability. This permits unique approaches to be developed as it shall enhance the application's reliability through its development. Furthermore, particular design approaches shall be discussed to enhance the reliability of the online application. Based on the suggestions, the relevance of the reliability management issues with regards to the development of the online application shall be critically discussed.

2. PROBLEM BACKGROUND

Private Higher Learning Institutions in Malaysia provide new applicants with two modes of application; online and manual. However, several challenges are encountered with regards to their online application as this may negatively affect a prospective student's perspective on the university's credibility. All software systems should be scalable as technology rapidly evolves. Reliability management issues arise due to changes in technology as it causes defects and faults within the system. These issues include infrastructure, database, and human reliability. In the early 1970s, international students who want to apply to a higher learning institution away from their home country would be required to manually fill an application and send it to the institution by post. Additionally, a response regarding the applicant's application would be sent back by post. Today, learning institutions across the globe provide its online application services to both prospective international and local students to ease the overall application process. With the rapidly evolving technologies, several institutions should permit their online application to evolve. However, when online applications were first developed, changes in technology were not expected, hence the system's infrastructure hinders online applications to grow. Reliability issues arise when an enhancement has been implemented into the system as errors are encountered due to the system's inability to support the changes. The database that has been adopted by the Private Learning Institution should be able to accept future changes. Several defects will be present in the online application if certain technologies are forced upon the system if the database does not support these enhancements. These defects may result in data loss during a transaction. It is common for a Private Institution's online application to look like the candidate's application has been successfully submitted. However, numerous files and personal information would have been absent when the user clicked the submit button. The interface of most Private Learning Institutions is not accommodating to the various users that utilize the online application. Courses vary from foundation to PHD, therefore, individuals interested in the courses differ in ages and nationalities. The design of the online application should be informative and attract prospecting students to utilize its functionalities. However, the online applications offered by Private Learning Institutions are designed for a certain group of users. This leads to confusion among the applicants regarding how to submit an application. This may be demonstrated in a scenario where international applications should certify their scanned passport prior to uploading the file to the application. However, many applicants will not know this procedure unless it has been clearly stated in the application. A majority of users who use a Private Learning Institution's online application are foreigners, nonetheless the system designers fail to accommodate to various groups of users. Effective reliability management would assist in eliminating issues that hinder the application from evolving and growing with technologies available today. This would improve the user's productivity when utilizing the application, prevent loss of applications, and allow the system to be more susceptible to change.

3. LITERATURE REVIEW

From manual applications to migrating applications on a cloud, online applications to enroll in universities have grown as technology advances where each enhancement includes reliability upgrades. Private Learning Institutions in Malaysia

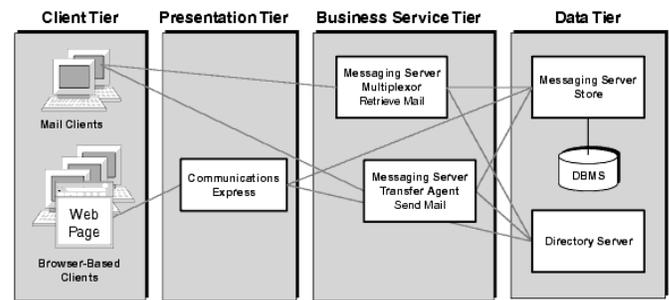


Figure 1 : *Reliable Infrastructure for Private Learning Institutions (Kamath, 2015)*

provide prospective students with a very simple yet cumbersome online application. This literature review will critically analyze existing reliability issues that are encountered as online applications evolve. Additionally, these issues will be broken down in order to understand and implement solutions that will enhance the reliability of Private Learning Institution's online application.

3.1 Reliability Issues in Infrastructure

Reliability issues pertaining to a system's infrastructure arise when the system's components are highly dependent and complex. Due to the system's high complexity, testing each data path in order to find faults is impractical and incurs a high cost (Saeid Saidia, 2018). This is because of the amount of man hours required to thoroughly check the data paths within a tightly coupled system. Additionally, this infrastructure is unreliable as technologies evolve for the reason that it violates the Open-Close principle where by a system must be open for extension and closed for changes. A system's infrastructure that supports high dependency within the system will have to undergo major reworks as technology advances, the system designers are liable for this issue. In less than 30 years, technology with regards to university applications have evolved greatly from manual applications to online applications (Xiangyang Guan, 2016). Technology today continues to grow exponentially, therefore, this requires the system's infrastructure to permit future enhancements relative to certain technologies. In addition to scalability, high dependency within the system affects the its runtime. This may be exemplified in a scenario where a failure may affect multiple components of the system. Figure 1 illustrates a suitable infrastructure that Private Learning Institutions in Malaysia should adopt to overcome the reliability issues that are faced with the infrastructure whereby the messaging protocols utilized are the prospective student's application.

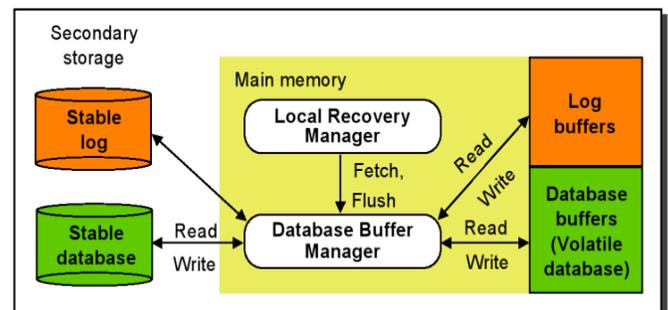


Figure 2 : *Model of the Recovery Algorithm (TutorialsPoint, 2019)*

3.2 Reliability Issues in Database

All Private Learning Institutions in Malaysia utilize a Distributed Database Management System (DDBMS) which updates the data when a new record (application) has been submitted from a different location (B.Johnsirani, 2015). The reliability of the adopted DDBMS is critical to ensure that the user requests are processed regardless of failures that may occur. Database engineers are liable when data is affected by failure such as hardware failures and transaction failures (B.Johnsirani, 2015). In order to guarantee a reliable DDBMS, each property of a transaction's durability and atomicity should be considered. Recovery systems should be employed to assure that transactions are efficiently managed when a failure occurs due to concurrent transactions as this is common in online applications. Figure 2 models a recovery algorithm that is utilized by many DDBMS, this model can be broken down into two parts: before and after the failure occurs. The initial part relates to the tasks that are executed during a transaction that ensures that sufficient data is gathered to recover from a failure; whereas, the subsequent part of the algorithm involves the tasks that are carried out to recover missing information after the failure has occurred (Rana, 2018). Although a Private Institution's online application adopts a DDBMS, recovery protocols are not adopted which results in lost data within the application. Additionally, this leads to redundant processes carried out by the applicant as they would be required to directly liaise with the person in charge in order to apply for a course.

3.3 Human Reliability issues

Human reliability issues must be taken into account as human errors are common in computer fields and the applicants utilizing the online application vary in age, nationality, cognitive biases, etc. Human reliability is unpredictable due to several factors that are involved whilst they are utilizing the online application. As per the Technique for Human Error Prediction (THERP), human errors can be categorized as Errors of Omission (EOO) or Errors of Commission (EOC) (Francesco Castiglia, 2015). The failure to execute a task is known as EOO while tasks that are performed unintentionally are categorized as EOC (Francesco Castiglia, 2015). The factors that are taken into consideration when calculating the probability of human errors are task complexity, available time that the user has, and whether training was provided. The probability of the influence of these factors to the user is illustrated in Figure 3.

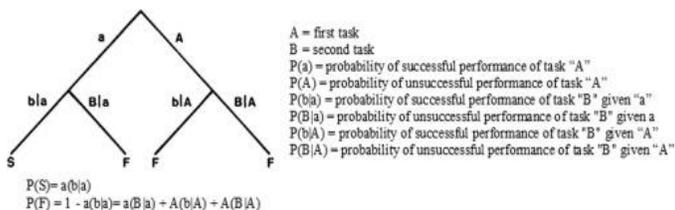


Figure 3 : Probability of Human Error Factors (Francesco Castiglia, 2015)

In order to maximize human reliability, developers should ease the process involved to submit an online application. The online application should be user friendly and informative. Additionally, developers should guarantee that users will be able to utilize the system with minimal to no training, though a user manual may be provided. When human reliability is

affected, the users and system designers are liable as there are standard protocols that are to be abided by when submitting an application. These protocols may include certifying certain documents and ensuring that the information provided is valid.

4. RELEVANCE OF ISSUE

By enhancing the current reliability of the online applications provided by several Private Learning Institutions, it can be determined that the system is not scalable and updated with the current technologies in the industry. This would require major reworks to the current system when novel technologies become a necessary standard to the Education industry. Private Learning Institutions in Malaysia provide prospective students with a simplistic system that consists of several reliability issues as the primary purpose of the online application (to submit the application online with ease) is not met. This is because several applications are lost during the transaction which prompts the applicant to directly liaise with the person in charge and submit the application manually.

The result of the literature review concludes that users, developers, users, and database engineers are liable for the respective reliability issues that are faced in the industry. Evaluating the system and identifying such issues enables changes to take place in the necessary components of the system in order to enhance its reliability. By adopting an appropriate infrastructure for the system, less modules will be affected by a failure and the implementation of a new requirement would be supported. This would minimize the testing stage of the system's development as the infrastructure eases the phase by reducing the dependencies within system; hence making it more modular. Subsequently, addressing the reliability issues involved in a Distributed Database Management System (DDBMS) assisted in identifying the primary cause for lost applications that were sent through the Private Institution's online application. Implementing recovery algorithms prepared the system to take the necessary actions before and after an error occurred. This achieves the online application's key goal and prevents redundant processes such as resubmitting the application. Furthermore, developers should design the system to accommodate human errors as human reliability is unpredictable. The development team is able to guarantee that the system allows various users to utilize it with ease and minimum training.

5. RECOMMENDATIONS AND PROPOSED SOLUTION

Online applications offered by numerous Private Learning Institutions face reliability issues pertaining to its interfaces, database, and infrastructure. To overcome these issues, reliability approaches shall be suggested by targeting the deeper components of the problem. These methods include implementing design patterns and algorithms to achieve the level of reliability required to enhance user productivity and allow the system to grow parallel to technology advancements. Design patterns may be utilized to surpass issues involving reliability issues regarding the system's infrastructure and interfaces. Private Learning Institutions in Malaysia started offering their applications online in the late 1980s; hence the systems are likely to have the characteristics of a legacy system. In order to bridge their current system with new technologies, an Adapter design

pattern may be implemented. This design pattern merges the capability of incompatible interfaces (Al-Samarraie, 2016). Additionally, applying the adapter pattern to the system's

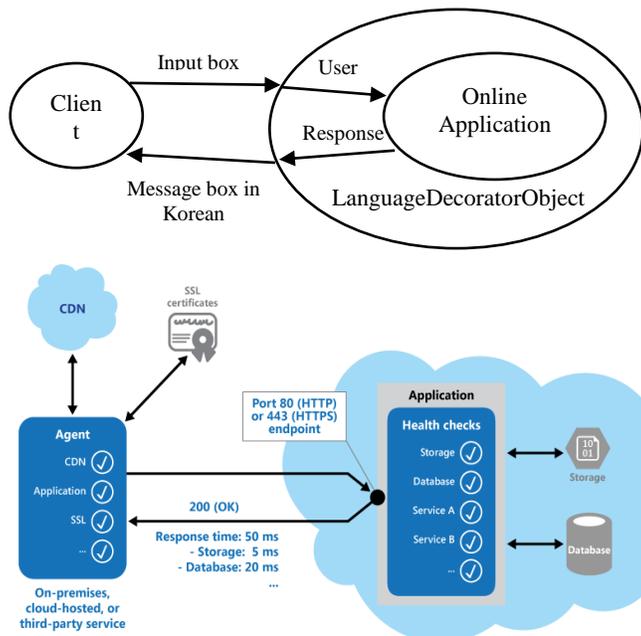


Figure 5 : Health Endpoint Monitoring Pattern (Narumoto, 2017)

architecture provides a more flexible design that permits system extensions. Interface issues affecting human reliability shall be subdued by applying the Decorator design pattern. This pattern permits additional functionalities to be inserted into the application without modifying the structure of existing objects (Mubin Ozan Onarcan, 2018). These functionalities may be created respective of various users as this enhances human reliability of the system. This may be represented in a scenario where language options (the decorator object) are available in the application in order to accommodate international applications as illustrated in Figure 4. Adopting recovery algorithms to the system's database will ensure that no data is lost during a transaction. This algorithm upholds the robustness of the selected database and enhances its reliability. Recovery algorithms are crucial for Distributed Database Management Systems (DDMS) as it is prone to failure mid transaction though users will not be aware of the failure. Furthermore, this algorithm prepares the system before and after the failure occurs so that the data being passed in the application form is not affected. With regards to the reliability issues faced in the system's infrastructure when extensions are compulsory, a cloud design patterns such as Health Endpoint Monitoring can be suggested. This design pattern assists in verifying if the services provided in the application performs as required before and after an enhancement (Narumoto, 2017). The Health Endpoint Monitoring pattern may be implemented in the Private Learning Institution's online application as illustrated in Figure 5. Furthermore, this pattern ensures that the employed infrastructure enhances the reliability and availability of the overall system. The implementation of design patterns and algorithms to the system enhances the reliability of the online application and eliminates liability issues that arise from the issues discussed. The system will result in a more scalable and maintainable application that guarantees user satisfaction. Furthermore, the application would be tailored to

each user without affecting the existing components of the system.

6. CONCLUSION

Effective reliability management prompts Private Learning Institutions in Malaysia to offer an online application that is prepared for future extensions and unexpected failures. Current reliability issues in the provided online applications were identified and analyzed in order to understand industrial liability. These issues hindered the system from growing with the technology advancements present today as the system's infrastructure was not susceptible to such changes. This decreased the system's reliability as the primary goal (an easier and faster approach to submit applications) of the online application was not achieved. The main reliability issues that were identified in online applications offered by Private Learning Institutions in Malaysia involved the application's infrastructure, database, and interface. The effects of these issues prevented the system from implementing new requirements without changing the existing components of the system. This led to defects within the system as applications were lost during the transaction. Furthermore, the online application had a uniform design that disregarded the multi-cultural characteristics of the Private Institution. This resulted in confusion among the applicants while using the system as it differed from online applications that were provided in their home country. Recommendations and suggested solutions were discussed to overcome the identified reliability issues within the online application. These solutions involved the implementation of certain design patterns and algorithms that ensured that design principles such as the Open-Close Principle were not violated. Implementing the solutions prevented data loss from occurring when the application was submitted. Furthermore, the online application will be able to tailor its design to a range of users by applying the suggested design pattern. This paper has successfully evaluated major issues regarding reliability management for online applications of Private Learning Institutions in Malaysia in order to understand the industrial liability. The relevance of the identified reliability issues to the systems development was discussed to compare the reliability of the online application before and after the implementation of the proposed solutions. Furthermore, applying the suggested solutions to the online application of Private Learning Institutions eliminated the reliability issues faced and encouraged the system to embrace future enhancements relative to the industry.

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